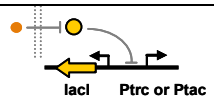
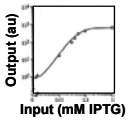
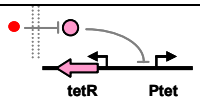
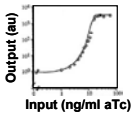
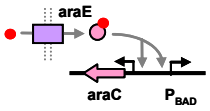
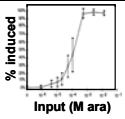
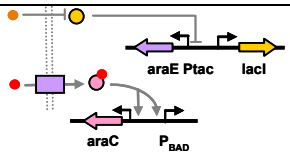
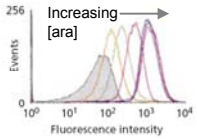
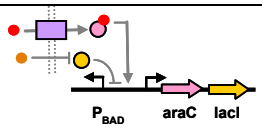
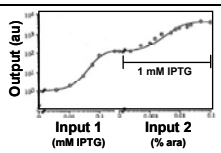
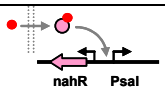
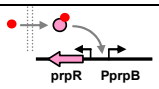
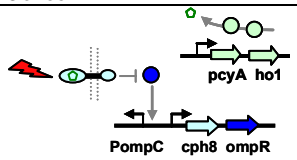
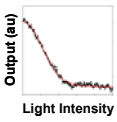
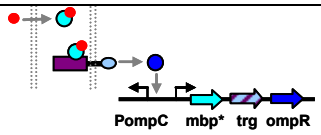
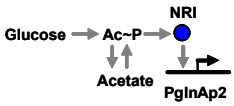
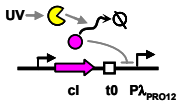
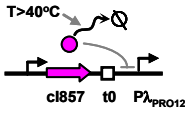
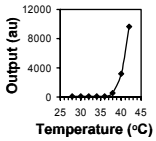
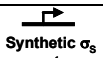
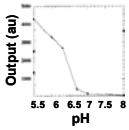
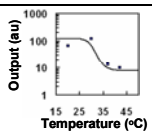
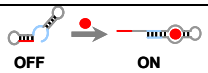
Table S1: Inducible systems

Name	Genes[a]	Performance	Notes	Ref
Lac		 • graded population induction	• lacI can exist in the genome or on a plasmid	[67]
Tet		 • intermediate induction difficult	• tetR can exist in the genome or on a plasmid	[67]
Ara		 • all-or-none response • 300-fold induction	• strain must transport (araE), but not metabolize (•araBCD) arabinose • also activated by CRP; sensitive to glucose in media	[68]
Graded ara			• turns ara system into graded response • strain must be •araBCDE • araE can be under inducible or constitutive control	[S1]
Ara-lac			• dual control by arabinose and IPTG • many variations/detailed parameters available • not dependent on growth media	[67,69]
Salicylate		• high basal activity • 20-fold activation		[S2]
Propionate		• 1500-fold induction • tunable intermediate induction • graded population • low basal activity	• glucose- and C-source sensitive	[S3]

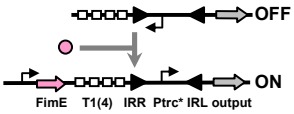
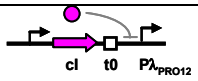
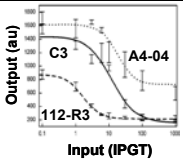
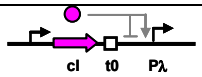
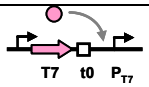
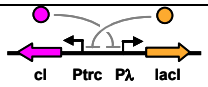
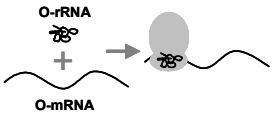
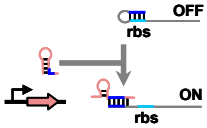
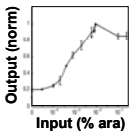
[a]Genes are displayed in the most space efficient manner, not necessary how they appear in the construct. See reference for genetic context. Unlabeled promoters are constitutive. Square boxes are terminators. The dotted lines represent the membrane.

Table S2: Cell-based sensors

Name	Genes[b]	Performance	Notes	Ref
Light		 • 10-fold induction • high basal activity	• responds to red light • requires *E. coli* RU1012 [21] • cyA/ho1 make the chromophore PCB • cph8 is chimera with EnvZ	[3**]
Engineered periplasmic binding proteins		• engineered maltose binding protein (mbp*) • mbp* variants can bind to many unnatural ligands	• requires *E. coli* RU1012 [21] • trg is tar-EnvZ chimera • useful when small molecule does not cross inner membrane	[2]
Glucose sensor		• also inducible by exogenous acetate	• NRI is expressed from the *E. coli* genome • requires NRII knockout • this system is not normally active in biotreactor conditions	[23,24]
UV		• turns on after a UV dose of 5 J/m^2	• the wild-type cI repressor is proteolyzed in response to UV	[70]
Heat			• cI repressor mutant • repressor degrades at high temperature	[S4]
Stationary phase		• mutants have 4 to 7000-fold induction ranges and 5 hour range of on-times	• library built based on random nucleotides around stationary phase sigma factor binding motifs	[S5]
pH			• controls genes involved in heavy metal export	[S6]
Cold			• also anaerobic-inducible • no OD dependence • cspA promoter can also be used [30]	BBa_S03385
Anaerobic		• basal activity at high copy	• involved in *E. coli* anaerobic respiration	[12**]
RNA aptamer		• transfer function can be tuned by varying the relative free energies of the ON/OFF states • transfer function tends to be very cooperative	• binding of small molecule, peptide, or protein either activates or inactivates mRNA • active form can be riboregulator (Table 3), ribozyme, or other functional mRNA	[31*,32**,33**]

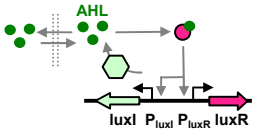
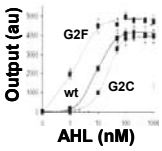
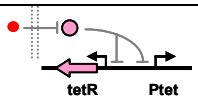
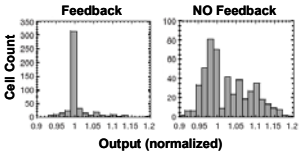
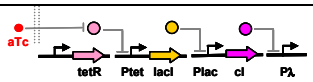
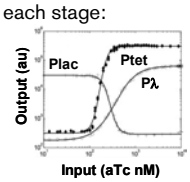
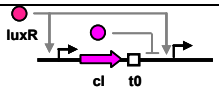
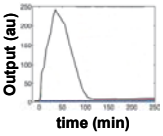
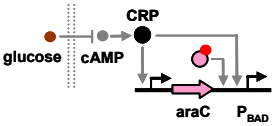
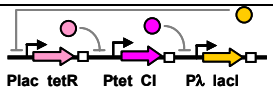
[b]Genes are displayed in the most space efficient manner, not necessary how they appear in the construct. See reference for genetic context. Unlabeled promoters are constitutive. Square boxes are terminators. The dotted lines represent the membrane.

Table S3: Switches and logic

Name	Genes[a]	Performance	Notes	Ref
DNA Switch		• irreversible / genetic memory • extremely low basal activity • pulse of input activates switch	• promoter controlling FimE cannot be leaky • probably requires ΔFimB/ΔFimE strain	[36*]
Inverter		 • transfer function with IPTG input	• can be built with other repressors (tetR and lacI work well) • mutants available with different transfer functions (*e.g.*, A4-04, C3,112-R3) • can also amplify a signal [75*]	[4]
Biphasic switch		• Pλ off at both low and high input	• the promoter has multiple cI binding sites with varying affinity that either activate or repress transcription	[39*]
Amplifier		• very high expression (~4-fold higher than IPTG-driven tac promoter) [35]	• T7 mutants available that bind to different nucleotide motifs [S8] • promoter variants are available that span acitivies from weak to very strong [S9]	[S7]
Toggle switch		• bistable; hysteresis in switch • epigenetic memory • all-or-none population dynamics	• inputs either small molecules or promoters that are linked to either repressor	[40]
Orthogonal ribosome pair		• orthogonal (O) RNA is designed to create a unique ribosome / rbs binding interaction	• can be used to generate AND or OR logic [46] • many different interaction pairs can be used simultaneously	[45**]
Riboregulator		 • 8- to 19- fold induction	• posttranscriptional control • small RNA (pink) exposes ribosome binding site (blue) • small RNA can be transcribed by an input promoter • the transfer function can be tuned by changing the binding energies	[37**]

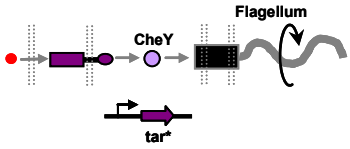
[a]Genes are displayed in the most space efficient manner, not necessary how they appear in the construct. See reference for genetic context. Unlabeled promoters are constitutive. Square boxes are terminators. The dotted lines represent the membrane.

Table S4: Dynamic circuits

Name	Genes[a]	Performance	Notes	Ref
Cell-cell Communication		 • transfer function for luxR variants	• *V. fisheri* luxIR most commonly used • parallel communication channels between lasIR (BBa_F1780 and BBa_F2790) and rhlLR [71*] • wild-type luxIR unreliable at 37°C • luxR can be used to repress promoters [72]	[6*]
Negative feedback		• reduces noise in cell population 	• promoter controlling tetR is engineered to have tetR binding sites • same strategy could be applied to most activator/repressor promoters	[S10]
Cascade		• steady-state transfer function of each stage: 	• each promoter can be used as an output to achieve a temporal program of events • each stage modifies the global transfer function	[15**,16**,47**]
Pulse Generator			• the response can be controlled by changing the cI rbs • is an incoherent feedforward regulatory motif [48]	[6*]
Delay		• ara-inducible system same as in Table 1; redrawn to show CRP feedforward motif • produces a time delay ~30 minutes • filters short pulses of input	• is a coherent feedforward regulatory motif [48] • same motif can be built out of different regulators	[50]
Oscillators		• period of 200 minutes • rapidly desynchronizes, cannot be seen in population	• other oscillators have been constructed based on an activator-repressor motif [50] and metabolic components [52**]	[5]

[a]Genes are displayed in the most space efficient manner, not necessary how they appear in the construct. See reference for genetic context. Unlabeled promoters are constitutive. Square boxes are terminators. The dotted lines represent the membrane.

Table S5: Actuators

Name	Genes[a]	Notes	Ref
Suicide		• kills bacterium when expressed	[9**]
Biofilm		• induces biofilm formation	[41**]
Adhesion / invasion		• causes *E. coli* to adhere to and invade cancer cells and mammalian cells expressing β1-integrins	[12**]
Surface display/ adhesion		• peptides can be displayed to bind to a specific surface • a positive/negative selection yielded peptides that adhere specifically to breast cancer cells	[65**]
Flagellar switch		• enables flagella rotation to be turned on and off • does not control swimming direction • requires ΔmotB strain	[57] (BBa_S 03271)
Chemotaxis		• wild-type tar responds to aspartate • tar chimeras (tar*) chemotax towards heterologous signals • additional required Che proteins not shown • exhibits adaptation	[26,27]

[a]Genes are displayed in the most space efficient manner, not necessary how they appear in the construct. See reference for genetic context. Unlabeled promoters are constitutive. Square boxes are terminators. The dotted lines represent the membrane.

References

S1. Khlebnikov A, Risa O, Skaug T, Carrier TA, Keasling JD: **Regulatable arabinose-inducible gene expression system with consistent control in all cells of a culture.** *J Bacteriol* 2001, **182**:7029-7034.

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